
Space Weather Technical Forecast

Issued on Monday 30 September 2024 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-flares (R1-R2 Blackouts). Chance of G1-G2/Minor-Moderate Geomagnetic storms day 2.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity is Moderate with an M1.7 observed at 29/1424UTC from AR3842 in the southeast quadrant.

There are currently nine sunspot regions on the visible disc. The most notable remains AR3842 in the southeast quadrant, which continues to show minor growth in its intermediate spots. This region contains a delta spot on the southern periphery of its main leader spot. AR3835 and AR3836, in the southwest, have shown a slight decaying trend. AR3839 and AR3843, in the east, are both exhibiting minor but continued growth. Two new regions, along with all other regions are small and simple at present.

No further Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of a weak coronal hole fast wind. Speeds started at background, near 350 km/s, rising to a peak of strong, near 550 km/s by 30/0300 UTC. Density was above average, with peak of 34 ppcc at 29/1241 UTC, before declining to below average values. Interplanetary Magnetic Field, Bt, was moderate, and briefly strong, with a peak of 15nT at 29/1450 UTC, ahead of coronal hole fast wind. The north-south component was mostly positive (northward) with one consistent period of moderately negative (southward) between 29/2230-30/0100 UTC. Phi angle was predominately negative (towards the Sun). Geomagnetic activity was mostly Quiet to Unsettled (Kp1-3), with two Active (Kp4) intervals (29/1200-1500 & 30/0000-0300).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels (at diurnal peak), with a peak value of 574 pfu at 29/1430 UTC. The associated 24-hour fluence was below the Active threshold. The 30/0000 UTC observation was 8.12e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a chance of further isolated M-class flares. There is a very slight chance of an isolated X-class flare, mostly likely from AR3842.

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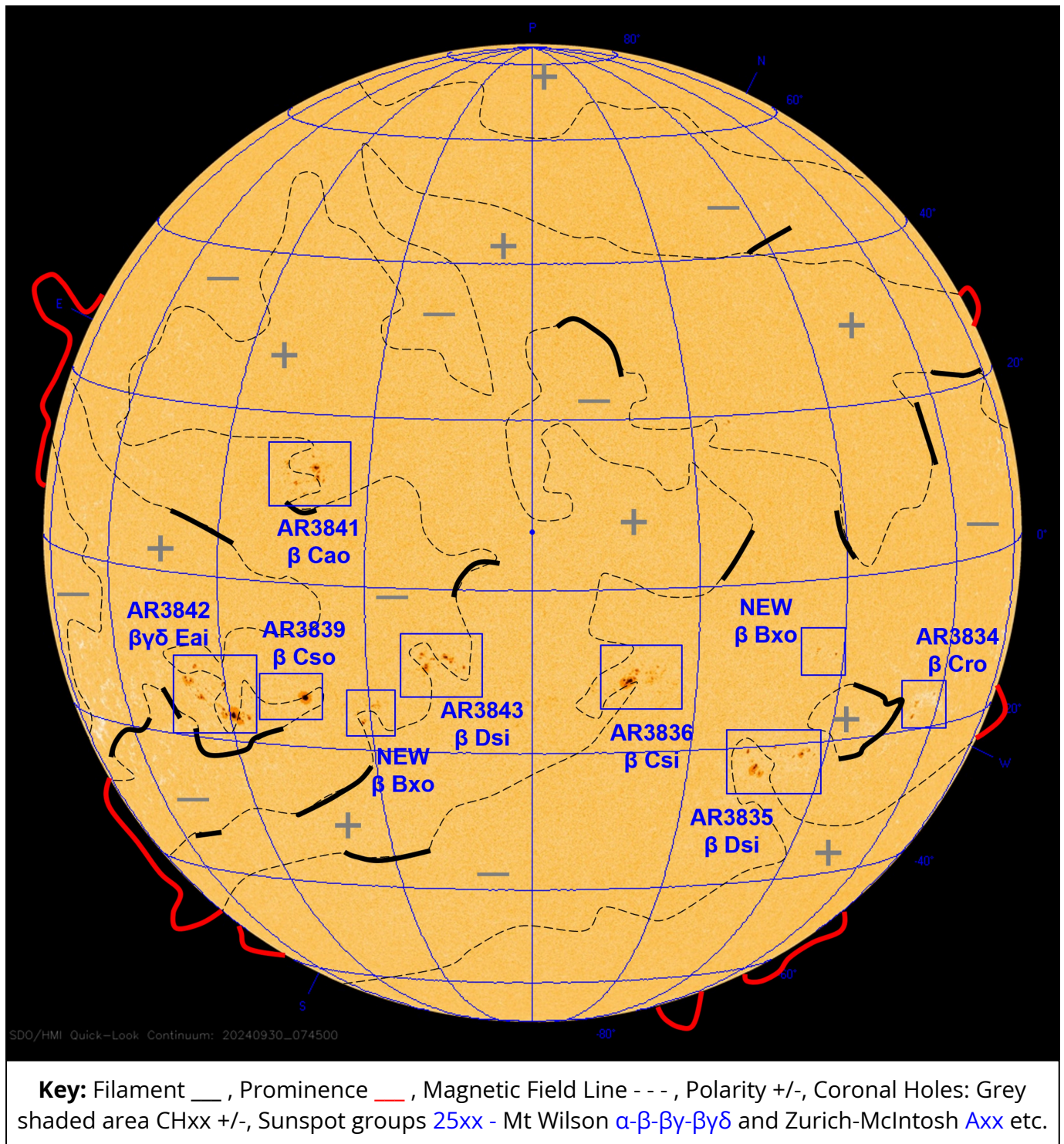
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Solar Wind / Geomagnetic Activity: A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been reanalysed with possible glancing impacts at Earth any time from early day 2 (01 Oct) until early day 3 (02 Oct). Solar winds are likely to remain slightly elevated on day 1 (30 Sep) due to coronal hole fast wind influences, before returning to background levels on day 2 (01 Oct).

Mainly Quiet (Kp 0-2) geomagnetic conditions are expected initially, with a chance of Unsettled to Active (Kp 3-4) intervals due to the waning coronal hole fast wind environment. There is then a chance of G1-G2/Minor-Moderate geomagnetic storms occurring day 2 (01 Oct) due to the glancing arrival of the 29 Sep CME, this risk continuing but reducing into day 3 (02 Oct). Confidence becomes lower by day 4 (03 Oct) due to the number of filaments currently on the disc.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background. High energy electron flux at GOES16 is expected to persist at Background, with an increasing chance of Moderate to High. The associated 24 hour fluence is expected to initially remain below the Active threshold (1e8 total pfu), though with decreasing certainty.

Figure 1: Solar Synoptic Map valid 30/0745 UTC.



Geomagnetic Storms

A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been reanalysed with possible glancing impacts at Earth early day 2 (01 Oct), but with low confidence in the speed due to lack of STEREO A imagery meaning that this CME may be slower than anticipated, perhaps with delayed effects starting on day 3 (02 Oct). Although the bulk of the CME will miss ahead of Earth's orbit, glancing impacts are now considered possible.

Solar wind speeds have been at slightly elevated to elevated levels, between 400-550km/s since the arrival of a fast wind from CH76/- during the second half of 29 Sep UTC. Speeds are now showing an erratic easing trend. In the absence of any CME, solar wind speeds should trend back to slightly elevated or background through the period. Although currently wind speeds in MOSWOC Enlil are tracking close to observations, the broad fast wind seen in Enlil is vastly overestimating the longevity of the current coronal hole fast wind. After the recent reanalysis of the 29 Sep CME, MOSWOC Enlil and Enlil ensemble are now displaying an increased risk of a glancing blow from this feature at Earth.

Mainly Quiet (Kp 0-2) geomagnetic conditions are expected initially, with a chance of Unsettled to Active (Kp 3-4) intervals due to the waning coronal hole fast wind environment. There is then a chance of G1-G2/Minor-Moderate geomagnetic storms occurring day 2 (01 Oct) due to the glancing arrival of the 29 Sep CME, this risk continuing but reducing into day 3 (02 Oct). Confidence becomes lower by day 4 (03 Oct) due to the number of filaments currently on the disc, as any disruption could result in an Earth-directed CME, and a subsequent increase in geomagnetic activity is possible later in the period.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	30	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil showing the close passage of the 29 Sep CME on day 2 (01 Oct).

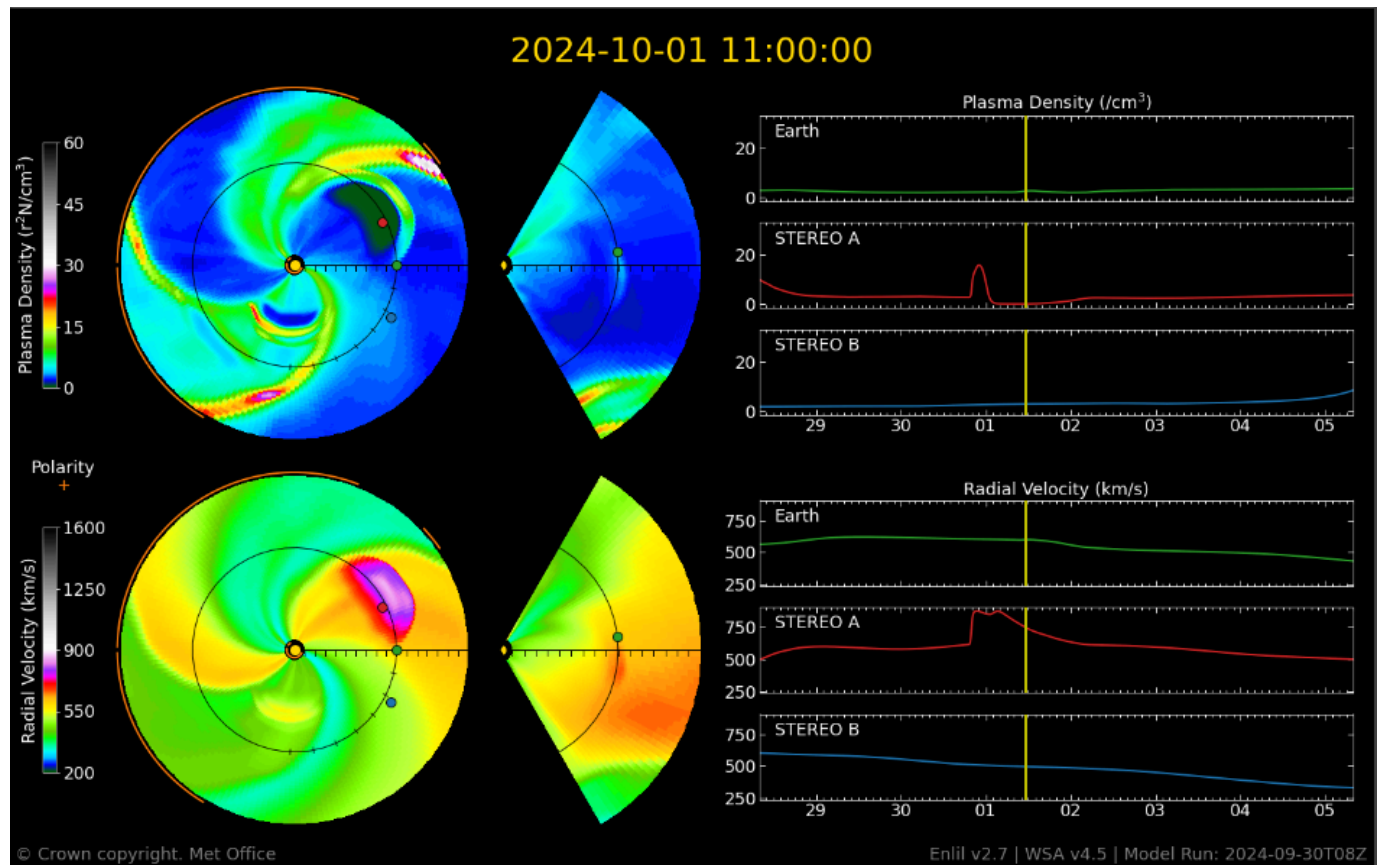
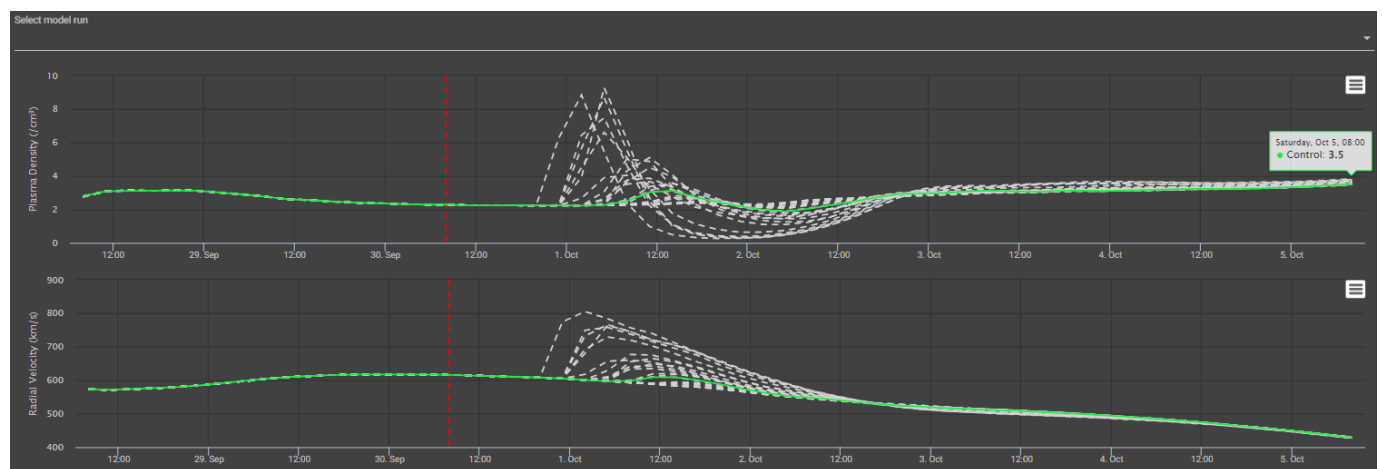


Figure 3: MOSWOC Enlil Ensemble showing several members with an arrival of the 29 Sep CME sometime on 01 Oct. Note the background solar wind speeds are above current and expected levels.



Radio Blackouts - X-Ray Flares

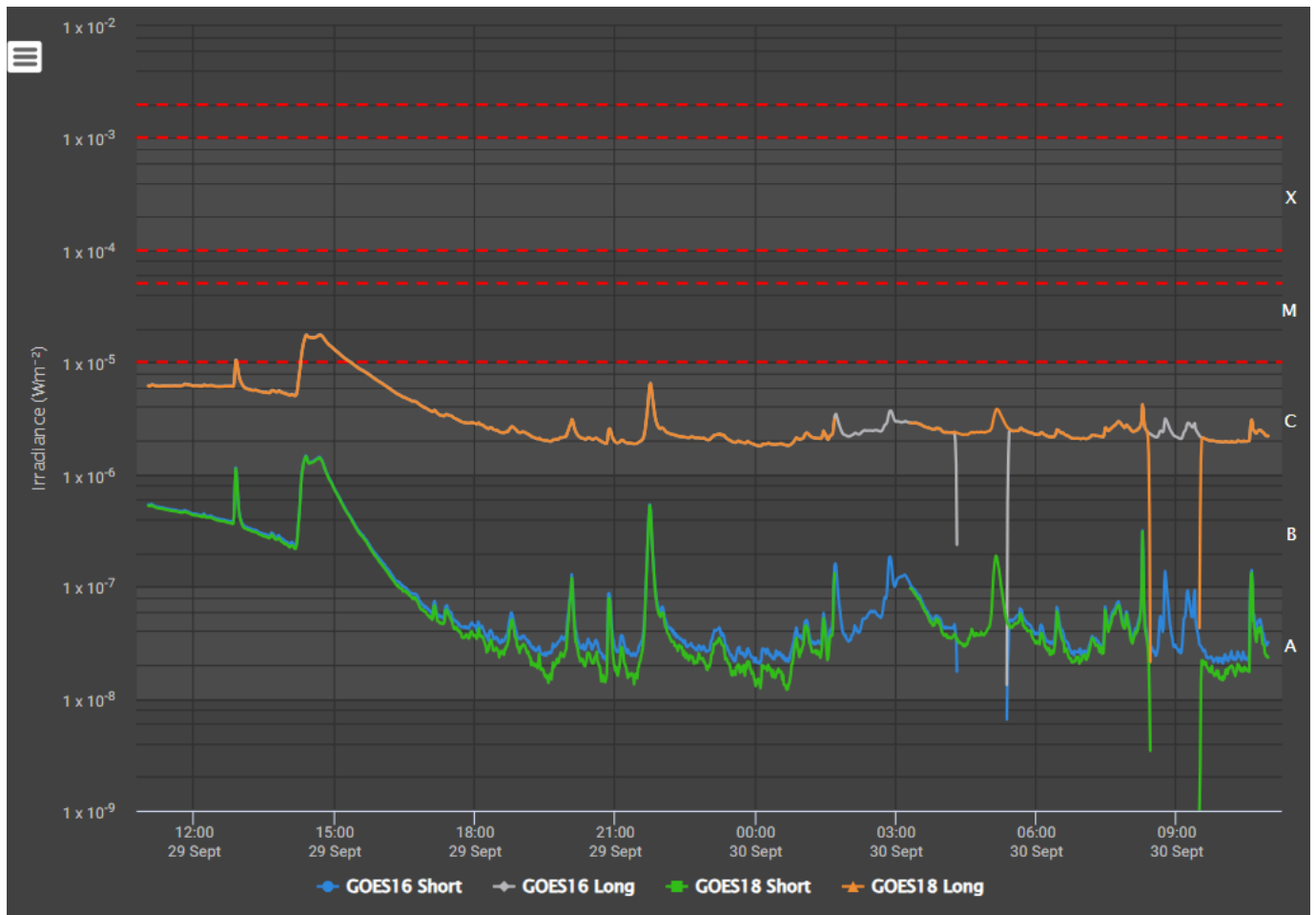
Low to Moderate activity is forecast with an ongoing chance of isolated M-class flares. There is a slight chance of X-class flares

There are currently nine sunspot regions on the visible disc. The most notable remains AR3842 in the southeast quadrant, which continues to show minor growth in its intermediate spots. This region contains a delta spot on the southern periphery of its main leader spot and was responsible for the largest flare of the period (M1.7 at 29/1424 UTC). This region is the most likely source of any larger or more significant flares.

The other regions are generally simpler, but include a few of note. AR3835 and AR3836 in the southwest, have shown a slight decaying trend. AR3839 and AR3843 are both exhibiting minor but continued growth.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	50	50	50	50
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 4: 24 hour X-ray trace.

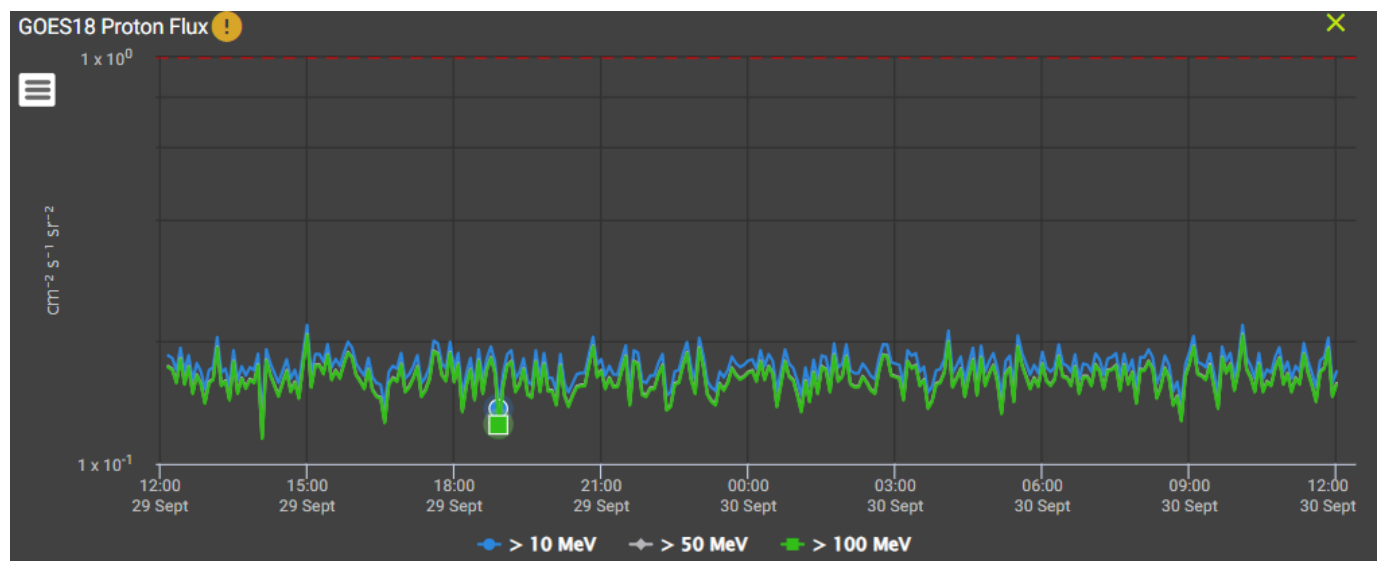


Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels. Many of the current visible sunspots are generally small and simple providing only modest contributions to flare risk, and are unlikely to significantly impact proton flux at Earth. However, the chance of Proton rich flares increases as AR3842 rotates closer to centre disk by day 2 (01 Oct). Also, given the number of notable filaments currently on the disc, there is also a very low, albeit non-zero chance of observable protons should any significant filament eruption occur during the period.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq S1$	No	10	15	15	15
Very Active	$\geq S3$ *	No	1	1	1	1
* $S3 \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and/or $50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

Figure 5:



High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels (at diurnal peak). Electrons are expected to remain at background levels after the recent arrival of a fast wind from CH76/-, which should keep them suppressed in the short-term. A recovery to Moderate or perhaps briefly High levels (at diurnal peak) is likely towards the end of the period.

The associated 24 hour fluence is forecast to stay below Active ($1\text{e}8$ total pfu), in agreement with MOSWOC REFM, although a slight increasing trend is likely towards the end of the period, but is still expected to remain below the Active threshold.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^8$	No	1	5	10	15
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 6: GOES16 24 hour electron flux trace.

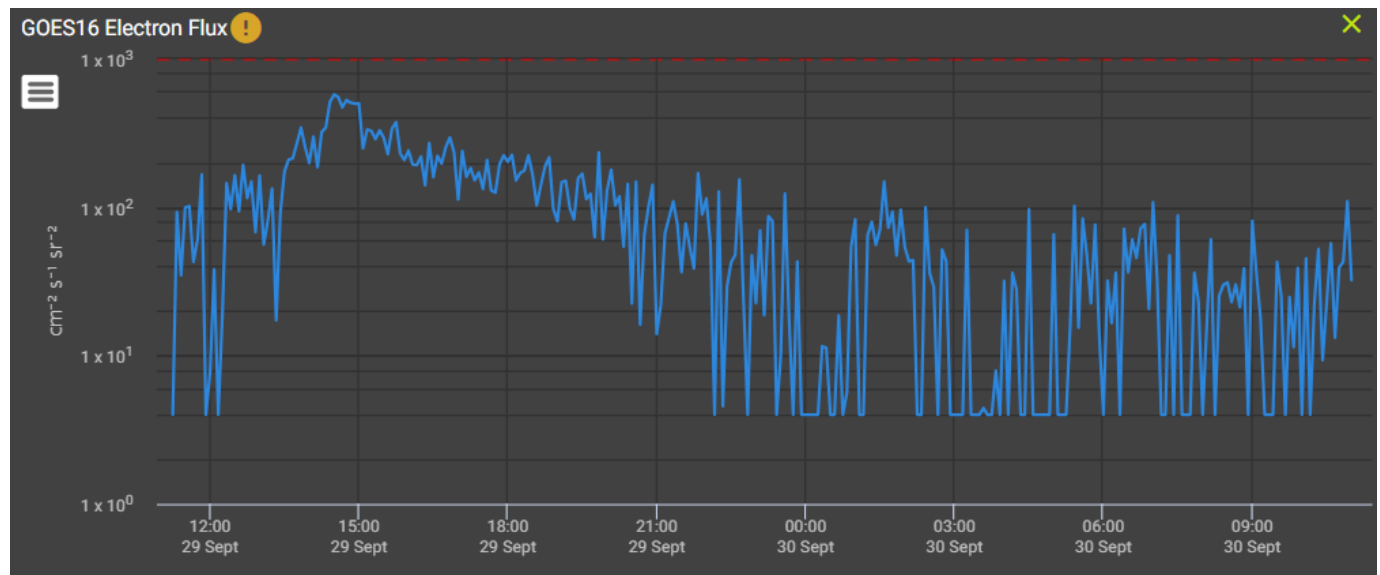


Figure 7: MOSWOC REFM integrated flux/fluence forecast, observations and recurrence.